E 1.33/3: 0054
Engr Docs

15640

DOE/PA-0054

UNIVERSITY OF NEBR.
LINCOLN LIBRARIES

FEB 24 1981

DEPOSITORY

Energy Backgrounder for the Captain America Comic Book

UNIVERSITY OF NEBRASKA-LINCOLN
R02328 38279

U.S. Department of Energy

ENERGY EFFICIENCY

The President's Program to Energy Efficiency

Energy Backgrounder for the Captain America Comic Book

Note to Educators ii

Introduction 1

Why Study Energy? 2

Where We Stand 3

What We Have 3

What's in Store 4

Conservation 6

For More Information 8

Glossary of Energy Terms 11

U.S. Department of Energy
Office of Public Affairs
September, 1980

NOTE TO EDUCATORS:

This book is published by the U.S. Department of Energy to support a conservation campaign aimed at American youngsters and their families.

With the exception of this book, the primary campaign materials, including the classroom comic book, poster, and public service radio and television announcements were produced under the direct guidance of the Department of Energy and were fully funded by the Marvel Comics Group, a division of Cadence Industries Corporation, and the Campbell Soup Company. The private sector funding encouraged the Department of Energy to create this classroom program without the expenditure of tax dollars.

DOE acknowledges the contributions of Marvel and Campbell, but offers no endorsement of their products. They have served as partners with DOE in this project. Their support has allowed a program to be created where there could have been none without additional Federal funding. DOE invites the cooperation of other private sector partners to create programs to our specifications and to the benefit of all Americans.

If you have any questions or comments concerning this program, please write to me.

Stephen A. Jacobs
Deputy Assistant to the
Secretary for Public Affairs
U.S. Department of Energy
Washington, DC 20585

INTRODUCTION

Children need to learn the seriousness of the energy situation in the United States. They should have some idea of how the high cost of energy affects their present-day lives; and they should understand that energy is a long-term problem, one that they themselves will be dealing with for most of their lives.

Energy's complexities have stymied many an expert's mind. Yet the basic principles of the energy situation can be made clear. That is the aim of the illustrated materials that accompany this publication. Posters help provide daily reminders of simple truths. Comic books, with their near-universal appeal to young readers, lend an air of excitement and suspense to an otherwise difficult subject.

A few words of explanation regarding the Captain America energy comic book and its contents may help make the material more effective. The story line introduces the reader to the various forms of energy, present and future, and the need to conserve energy.

The quizzes and puzzles interspersed throughout are designed to encourage careful study of energy terminology.

For the most part, the comic book's story line contains all the information that the student will need to complete the quizzes. Occasionally, however, the text may provoke questions that it does not answer. Few elementary students, for example, are likely to be familiar with the Darrieus windmill (see "Wind Power" in the Glossary of Energy Terms on page 14).

The glossary contains a number of important energy terms—those used in the comic book plus others rapidly coming into everyday use.

There are certain ambiguities in energy terminology—partly because energy technology is a rapidly developing phenomenon. Solar energy, for example, indisputably means energy from the sun. Less widely recognized is the fact that wind power is likewise solar energy, inasmuch as it is the sun's heat that causes the movement of air currents that we know as wind. Hydroelectric power, too, can be said to be a form of solar energy; because of the sun's heat, water evaporates, rises,

condenses, falls as rain, collects in rivers and streams, and finally flows through the turbines of electric generating plants.

Synfuel is another energy category that defies simple definition. At present, efforts to develop a synthetic fuels technology are being concentrated largely on coal–specifically, on converting coal to clean-burning synthetic liquid and gaseous fuels.

But national policy also calls for making synfuels by distilling oil from shale and by recovering the energy in organic materials, or biomass. Biomass could be municipal waste, such as "urban ore" (see page 19 of the comic book), or it could be alcohol distilled from grain for use as gasohol. Hence in the matching quiz on Fun Page #1, the term "Synfuel" is matched with the clue "Shale and Grain".

Note that "Re-used trash" is matched with "Recycling". Should it not be matched with "Synfuels", if, as we have said, trash is biomass? Not necessarily. Not *all* trash is biomass, or organic material. Many municipalities have made serious efforts to recycle inorganic waste materials such as metals and glass. Recycling is a mechanical rather than a thermal or chemical process. Recycling not only conserves mineral resources but usually requires less energy than it takes to mine and process virgin mineral ores.

Obviously, fine distinctions abound in the energy lexicon. For the most part, the terms used in the comic book to describe the major energy sources should be adequate for most classroom purposes, with this publication and its glossary and other supplemental information providing additional clarification.

The centerspread of the comic book contains a chart showing major developments in energy history. Again it should be emphasized that this highly condensed presentation represents only the highlights of a complex and eventful history.

A list of general-interest and educational DOE energy publications has been included in this publication, along with a list of other energy-oriented institutions throughout the country, all of which have available a wide range of energy information.

WHY STUDY ENERGY?

America's prosperity and high standard of living have been based upon readily available, inexpensive, and seemingly inexhaustible energy resources such as wood, coal, oil, and natural gas. Our industrial strength, our agricultural bounty, our comfortable homes, our fast and easy transportation–all consume large amounts of energy.

About half of that energy is oil. Unfortunately, the world's supply of oil is limited and production is leveling off. The United States used to produce almost all its own oil and export some. Now it must import almost half its needs. This heavy dependence on foreign oil producers makes the Nation vulnerable both to sudden interruption in supply and to sudden increases in the price of oil. Unless we wish to invite economic depression, these vulnerabilities must be removed by shifting the Nation's reliance to alternative sources of energy.

Both as a means to teach people to conserve energy, and to develop the skills needed for new energy technologies, America must increasingly stress energy in classrooms throughout the educational system.

WHERE WE STAND

In the United States, we use some 16 times as much energy as we used 100 years ago–but the population has increased only fourfold. This means that each American is using about four times more energy than his or her great-grandparents did.

With the recent emphasis on energy conservation, and with steadily rising energy costs, Americans are paying more attention to their habits of energy use. American industry has actually reduced its share of national energy consumption, while increasing its output.

Overall, the growth rate in national energy use has recently slowed from more than five percent per year in the late 1960s to less than two percent.

WHAT WE HAVE

Domestic energy reserves in the United States consist primarily of petroleum, natural gas, coal, and uranium.

Petroleum continues to be the Nation's most sought-after fuel by far. Once a major exporter of oil, the United States began in the late 1940s to consume more oil than it could produce. We have been a net importer of oil since, and will continue to be for the foreseeable future.

Although domestic oil production has reached a plateau, new technology could substantially expand potential reserves. For example,

two-thirds of the oil in an oil field remains in the ground following existing recovery methods. New recovery techniques would permit tapping some of this reserve. Similarly, enormous deposits of petroleum exist in the form of tar, and of oil too heavy to be pumped by conventional means. Methods of liquefying these fuels would likewise bolster the Nation's oil reserves.

But demand will continue to outrun petroleum supply, both nationally and worldwide. Indeed, one of the more sobering aspects of the energy situation is that oil production capacity in the Persian Gulf states may have been substantially overestimated, and that world demand will begin to exceed world supply sooner than expected, perhaps in the early or mid-1980s.

Natural gas is likewise being used faster in the United States than new deposits are being discovered. Recent pricing policy changes have served to reduce demand somewhat, however, and supplies are expected to be adequate for near-term demands. As with petroleum, difficult-to-reach gas deposits will eventually be tapped through new technology.

The Nation has enough coal to last for hundreds of years, but research is needed to solve its environmental problems.

Fossil fuels make up the bulk of the United States fuel supply, but nuclear energy also contributes significantly, accounting for about 12 percent of the country's electric power production.

WHAT'S IN STORE

Although the Nation will continue to depend on petroleum for many of its energy requirements, technology will provide other options.

Synthetic fuels offer promise not as an additional energy source alone, but as a source of the critically important liquid fuels—chiefly gasoline.

Coal, the most abundant of the Nation's fuel resources, can be converted into liquid fuel, gaseous fuel, or clean-burning solid fuel. Large-scale plants are being constructed by Government and industry to test and improve all three processes.

Shale oil is probably closer to commercial production than the coal-derived synthetics. The basic technology is available and shows promise of producing one of the least expensive alternatives to present domestic fuels. Government incentives may be necessary to help establish a commercial shale oil industry, however.

Biomass fuels—produced from organic materials through distillation and other processes—are in an early stage of development in this country but are expected to play a significant role in the Nation's fuel program.

Gasohol—a blend of gasoline and alcohol—is expected to have an especially strong impact in the near term.

For the long term, three major energy options are being pursued by Government and industry researchers. These include solar, geothermal, and fusion technology.

Solar energy has attracted widespread attention as a clean, inexhaustible energy source, and is already being put to use in many homes and commercial buildings. Much greater contributions can be expected in the 21st century, when the technology is more fully developed. Possibilities include solar power towers, windmills, photovoltaics, solar power that is beamed to earth from a space installation, and recovery of power generated by variations in ocean temperatures and by ocean currents.

Geothermal energy—the heat stored in the earth—is also already being used in various parts of the world. Although it is expected to be primarily of regional significance, geothermal energy could account for an appreciable fraction of energy use in areas such as the West Coast. Further exploration could greatly increase the contribution of this energy source by the year 2000.

Interest in *fusion* as an energy source stems from the essentially inexhaustible nature of its fuel supply. Deuterium, a fusion fuel, can be recovered from seawater. Two concepts of fusion are now under study; one will be selected for further testing early in the next century. Commercial production could come by 2025.

A fourth long-term possibility is the *breeder reactor*. Breeder reactors produce more fuel than they consume, a feature that will prove most attractive once supplies of uranium, the traditional nuclear fuel, begin to decline. However, breeder reactors produce the element plutonium, which can in turn be used to make nuclear weapons. Development of the breeder is therefore being deferred until this problem can be resolved.

CONSERVATION

Energy in the United States has been cheap and the result has been waste. How many times have we walked out of a lighted room without bothering to turn out the lights? Or driven a couple of miles to pick up an unimportant item? These wasteful practices must be eliminated. Shortages and higher prices are teaching us a hard and important lesson: We must learn to conserve energy and use it more wisely. Proper conservation measures can help extend our energy supplies far into the future.

We must learn, for example, how to make our electric system more efficient, from start to finish. On the average we are recovering less than 80 percent of the coal from the ground and about 30 to 40 percent of its potential energy is converted to electricity. We must do better. Almost 10 percent of the energy is lost over electric transmission lines. Methods are available for reducing this. More efficient plants and transmission would significantly reduce pollution.

Many industries could use energy more efficiently. Changing the rates utilities charge for electricity, in order to encourage conservation by industry, would make saving energy profitable. It is estimated, for example, that over three percent of our total energy is used by the aluminum industry. It takes much less energy to recycle aluminum than it does to produce aluminum from ore. Thus, higher energy costs would not only reduce industrial consumption, but might also have the happy result of getting discarded cans and bottles off our roadsides.

In the effort to save gasoline, the individual motorist can take some significant steps.

- Use public transportation.
- Form car pools.
- Drive at reasonable speeds; no fast stops and starts; avoid racing the engine or letting the engine idle for long periods.
- Keep trips to a minimum; consolidate shopping trips and other errands.
- Keep the car engine well tuned.

In our homes and commercial buildings there are ways to make important savings. Construction standards are now being changed; for example, adequate insulation could save up to 50 percent on home heating costs and air conditioning costs. Most commercial buildings have been overheated, overcooled, and overlighted. Better architectural design could reduce commercial heating and lighting demands by using less glass, better insulation, and appropriate heating and lighting systems.

Significant amounts of energy can be saved in houses and apartments, too:

- Install weather stripping on doors and windows.
- Install storm doors and windows.
- Have the furnace checked and cleaned regularly.
- Close the fireplace damper when not in use.

It has been estimated that turning all thermostats down two degrees in the winter and raising them two degrees in the summer could save more than half a million barrels of oil a day.

Household appliances also use a lot of energy, some of it unnecessarily. Labeling recently required by Congress can help buyers of appliances judge which models best suit their energy conservation objectives.

There are other ways of conserving energy on home appliances and lighting:

- Use cold water in the washing machine.
- Do not wash dishes with hot running water.
- Repair leaky faucets.
- Forego the luxury of frost-free refrigerators and freezers.
- Install fluorescent lamps instead of standard light bulbs.

FOR MORE INFORMATION

General Interest Publications

The following publications are available from Energy, P.O. Box 62, Oak Ridge, Tennessee 37830.

Energy and You. 1979. 6 pages A brief discussion of ways in which each citizen can conserve energy. EDM-1115.

Energy-Saving Checklist for Home Builders, Buyers, and Owners. 1979. 4 pages. Items to consider when building or renovating a home or improving its energy efficiency. EDM-344.

How to Improve the Efficiency of Your Oil-Fired Furnace. 1978. 9 pages. Tells homeowners how to save money and reduce pollution by having their oil-fired heating systems serviced regularly. EDM-1086.

How to Save Gasoline . . . and Money. 1979. 7 pages. A guide to conserving energy for car owners and drivers. EDM-330 (English); EDM-330A (Spanish).

How to Understand Your Utility Bill. 1980. 12 pp. Popular guide to reading electric and gas meters and checking utility bills, so that householders may know how much energy they use and how efficiently they conserve it. Includes annual operating costs for major home appliances. EDM-1085.

Insulate Your Water Heater and Save Fuel. 1978. 3 pages. Describes a kit that can help a homeowner increase the insulation on a water heater and estimates the savings that could result. EDM-080.

Low Cost/No Cost. 1980. 14 pages. Outlines a number of inexpensive and free ways to save energy in your home. EDM-356.

Tips for Energy Savers. 1978. 46 pages. Offers practical and simple ways to save energy in the kitchen, workshop, garden, and in the car; includes energy-saving considerations when buying appliances and other household merchandise. EDM-064 (English); EDM-065 (Spanish).

Educational Publications

Please note that the following publications are curriculum materials that have been prepared for the use of classroom teachers.

Easy Energy Reader. Grades 6-11. A series of four booklets: What is Energy?, 88 pages; History of Energy, 76 pages; Energy: What Can We Do Right Now?, 68 pages; and Energy: What About the Future?, 60 pages, which are designed for use in Language Arts classes. Each booklet contains several short articles relating to energy. EDM-1136.

Primary Grades

The Energy We Use. Grade 1. Study units include "Energy in Wind", which involves a pinwheel parade to show the energy of the wind; and "The Sun", in which students watch two plants to see how the sun gives them energy. 1977. 42 pages. EDM-1029.

Upper Elementary

Science Activities in Energy. Grades 4-6. Below is a series of simple, hands-on science experiments designed to help students learn about various forms and sources of energy. File folder units include the following titles:

Chemical Energy - Science Activities in Energy. 1977. 26 pages. EDM-1054.

Conservation - Science Activities in Energy. 1977. 28 pages. EDM-1049.

Electrical Energy - Science Activities in Energy. 1977. 30 pages. EDM-1053.

Solar Energy - Science Activities in Energy. 1977. 23 pages. EDM-837.

Wind Energy - Science Activities in Energy. 1978. 24 pages. EDM-855.

These organizations can furnish information about energy. Most provide books and other materials, films, and speakers on request.

American Gas Association
1515 Wilson Boulevard
Arlington, Virginia 22209

American Petroleum Institute
1801 K Street, N.W.
Washington, D.C. 20006

American Public Power Assn.
2600 Virginia Avenue, N.W.
Washington, D.C. 20037

Atomic Industrial Forum
7101 Wisconsin Avenue
Washington, D.C. 20014

Ecology Forum
124 East 39th Street
New York, NY 10016

Edison Electric Institute
90 Park Avenue
New York, NY 10016

Energy Information Center
505 King Avenue
Columbus, Ohio 43201

National Audubon Society
1130 Fifth Avenue
New York, NY 10028

Sierra Club
1051 Mills Tower
San Francisco, Cal. 94104

Solar Energy Research Institute
1536 Cole Boulevard
Golden, Colorado 80401

U.S. Department of Energy
Office of Public Affairs
Washington, D.C. 20585

U.S. Department of the
Interior
18th and C Streets, N.W.
Washington, D.C. 20240

U.S. Environmental
Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

GLOSSARY OF ENERGY TERMS

Atom—The basic building block of all matter, an atom is the smallest particle of a chemical element (such as iron, hydrogen, gold, or uranium) that still has the properties of that element.

Barrel—A unit used to measure petroleum which is equal to 42 U.S. gallons. One barrel of crude oil has the same energy as 350 pounds of coal. (Not to be confused with a normal drum, which contains 55 U.S. gallons.)

Biomass Fuels—Fuels produced from organic materials through distillation and other processes.

Breeder Reactor—A nuclear reactor that makes more nuclear fuel than it uses by changing certain atoms, which will not split, into atoms that will split.

British Thermal Unit (BTU)—The amount of heat necessary to raise the temperature of one pound of water 1° F.

Coal—A solid fuel, mostly carbon, formed from the fossils of plants living hundreds of millions of years ago.

Coal Gasification—A chemical process to change coal into a fuel similar to natural gas; the biggest advantage is that sulfur and other pollutants in coal can be removed before it is burned.

Coal Liquefaction—A chemical process to change coal into liquid fuels similar to gasoline and kerosene.

Crude Oil—Liquid fuel believed to have been formed from the fossils of animals and plants at the bottom of ancient seas; petroleum as it comes from the ground.

Deep Mining—Mining that must be performed by digging underground shafts and tunnels.

Efficiency, Thermal—A measurement of how efficiently any device changes heat into another energy form. For example, a modern coal-burning electric plant has about 38 percent thermal efficiency because just under four-tenths of the heat from burning the coal is actually changed into electricity.

Energy—The ability to do work or to make things move.

Fission—The splitting of the nucleus (or center) of one atom into two or more smaller atoms; fission releases large quantities of energy.

Fly Ash—Tiny particles of solid ash in the smoke when fuels such as coal are burned.

Fossil Fuels—Primarily coal, petroleum, and natural gas. This term applies to any fuels formed from the fossils of plants and animals that lived eons ago.

Fuel—Anything that can be burned or fissioned to produce heat energy.

Fusion—The process of combining the nuclei or centers of two light atoms to form a heavier atom; fusion can release great quantities of energy. The sun produces its energy by fusion.

Geothermal Energy—Heat energy produced deep within the earth, largely by radioactive materials that occur there naturally.

Geothermal Steam—Steam formed by underground water seeping through hot rocks deep beneath the earth's surface.

Horsepower—A unit that measures the rate at which energy is produced or used. A man doing heavy manual labor produces energy at a rate of about .08 horsepower.

Kilowatt—A unit that measures the rate at which energy is produced or used. Ten 100-watt light bulbs use energy at the rate of one kilowatt (equal to 1000 watts). A rate of one kilowatt maintained for one hour produces or uses one kilowatt-hour of energy (equal to 1000 watt-hours).

Magnetohydrodynamics (MHD)—A process that uses a magnetic field to produce electricity directly from the hot smoke and gases from burning coal and/or oil.

Megawatt—One thousand kilowatts.

Natural Gas—Gaseous fuel believed to have been formed from the fossils of ancient plants and animals; often found with crude oil.

Natural Uranium—Uranium as it is found in the ground; a mixture of two types of uranium atoms. Less than one percent of the atoms in natural uranium are the kind that will produce energy in a nuclear reactor.

Nuclear Power—The energy produced by splitting atoms (such as uranium) in a nuclear reactor.

Oil Shale—Rock formed by silt and mud settling to the bottom of ancient seas and containing a substance similar to crude oil. So-called shale oil can be removed from the rock by heating and then used to make gasoline, kerosene, etc.

Petrochemicals—Chemicals removed from crude oil at the refinery and used to make a wide range of products such as plastics, synthetic fibers, detergents, and drugs.

Petroleum—See crude oil.

Photosynthesis—The process by which green plants convert sunshine into chemicals.

Plutonium—A heavy, man-made, radioactive metal produced in nuclear reactors. Because it could be used to make nuclear weapons, methods to restrict access to plutonium are being sought worldwide.

Radioactivity—A spontaneous change in the nucleus or center of an atom, accompanied by the release of energy called nuclear radiation.

Solar Energy—Electricity, heat, or other useful energy produced from sunshine.

Solar Power Satellite—A satellite that could be placed in orbit above the earth's equator, where it would be exposed to continuous sunlight. The satellite would collect solar energy and beam it back to earth by microwave, where it would be converted to electricity. Feasibility studies of such a power source are now underway.

Steam Electric Plant—An electric power plant (either nuclear or one that burns coal or other fuel) in which heat boils water into steam, the steam is used to spin a turbine, and the turbine spins a generator to produce electricity.

Strip Mining—Mining for coal or useful ores by removing the soil and rock found above them, rather than by tunneling underground.

Synfuels—Fuels made from unconventional sources, such as biomass or oil shale; or fuels made from conventional sources such as coal but modified so they can be burned in liquid or gaseous form.

Thermal Pollution–Harmful effects to the environment that may be produced by heat released by electric power plants into nearby lakes, rivers, or oceans.

Thermonuclear Fusion–See fusion.

Wastes, Radioactive–A by-product of producing power by splitting atoms in a nuclear power plant; some of these materials are highly radioactive and stay radioactive for long periods of time.

Wind Power–The use of windmills to convert wind into useful energy. Many new, efficient wind turbines are being developed by researchers. One such is the Darrieus vertical axis turbine with airfoil blades that uses the same principle as an airplane wing.